REMARKS

Claims 1-7, 18-21 and 23 are all the claims pending in the application.

The Examiner objects to claim 4, but indicates that it would be allowable if rewritten in independent form including all of the limitations of the base and intervening claims. The Examiner indicates that the prior art does not teach or disclose a concave portion having a reverse mesa form as claimed in claim 4.

The Examiner rejects claims 3 and 5 under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claims 3 and 5 are amended herein to more clearly recite the features of the invention. These amendments do not narrow the claims beyond their original scope.

The Examiner rejects claims 1, 6, 7, and 23 under 35 U.S.C. § 103(a) as allegedly being unpatentable over U.S. Patent 5,608,749 to Kizuki. The Examiner also rejects claims 1, 5, 7, and 23 under 35 U.S.C. 103(a) as allegedly being unpatentable over U.S. Patent 6,108,361 to Fujihara et al. Claims 1 and 23 are independent claims, with claims 5-7 depending from claim 1. Therefore, the following arguments traversing the rejections will focus on claims 1 and 23. Claims 5-7 should be allowable at least by virtue of their dependency on claim 1.

Kizuki and Fujihara either separately, or in combination, do not teach or suggest all of the features of the invention as claimed in claims 1 and 23. The Examiner acknowledges that Kizuki and Fujihara do not disclose or suggest that the concave portion or the groove extend at least through the thickness of the substrate as required by claims 1 and 23. The Examiner alleges that Kizuki states that the distance from the active layer to the edge of the concave portion be as

small as possible. The Examiner cites the last paragraph of column 2 to support this position. However, the cited portion describes the thickness of the active layer 4 to the side surface of the PHS electrode 8. This thickness can be adjusted by varying the active layer 3 thickness or the cladding layer 2 thickness without implicating the depth of the concave portion at all. This would provide the heat dissipation without adjustment to the concave depth. The Examiner's rationale is purely speculative. Kizuki suggests also that the substrate be thick enough to physically support dividing the laser diode into chips (Kizuki, column 3, lines 1-4).

Furthermore, Kizuki states that it is "extremely difficult" to narrow the facet to be as thin as possible (Kizuki, column 3, lines 40-47). Kizuki also discloses that some portion of the substrate 8 must remain intact in order to preserve the structural integrity of the diode (Kizuki, column 2, lines 40-47). Because Kizuki discloses the importance of retaining some thickness of the substrate after the layers of the diode are formed, it would not have been obvious to form the groove or concave portion to a depth at least equal to the thickness of the substrate as required by claims 1 and 23.

Fujihara does not discuss at all the depth to which a groove must be formed in the substrate. Fujihara discloses narrowing the width of the opening in the semiconductor layers in relation to the width of the mesa portion in order to decrease the temperature (Fujihara, column 4, line 63 through column 5, line 8). Fujihara does not disclose or suggest reducing the thickness of the substrate in order to reduce temperature as the Examiner alleges. Therefore, it would not have been obvious to reduce the thickness of the substrate in Fujihara in order to reduce the temperature since the reduction in dimension relates to a different feature than directed by the language of the claims.

Because it would not have been obvious from either Kizuki or Fujihara to extend the concave portion or groove to a depth at least equal to the thickness of the substrate, claims 1 and 23 are patentable over these references at least for this reason. Claims 5-7 are allowable at least by virtue of their dependence on claim 1.

With the claimed features of claim 1, the present invention has advantageous effects in performance and process yield over the prior art references, such as US Patent Nos. 6,108,361, 5,608,749 and the like.

The Examiner rejects claims 2-3 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 6,281,524 to Yamamoto et al. in view of Fujihara. The Examiner acknowledges that Yamamoto does not disclose that "the concave portion is filled with a metal having higher heat conductivity that the semiconductor layer" as claim 2 requires. The Examiner cites Fujihara to supply this deficiency. Applicants traverse this rejection by noting that Yamamoto and Fujihara are not combinable in the manner suggested by the Examiner.

As shown in Figures 18-20, Yamamoto discloses that an electrode 211 is formed in the groove 208 (Yamamoto, column 11, lines 13-35). The figures show that electrode 211 is deposited only on the surface of the groove. The groove is not filled, as the claim requires. Furthermore, Yamamoto discloses in Figure 26 how the semiconductor device is mounted a the heat sink, such that the heat conducting metal does not come into contact with the electrode 211 (Yamamoto, column 13, line 9-14 and Figure 26). The semiconductor device in Figures 18-20 is designed to provide a simple mounting to a heat sink using a minimum of solder (Yamamoto, column 11, lines 50-55). Yamamoto would not function properly if the groove 208 were filled with the heat sink, because it would short-circuit the electrode 211, rendering the device of

Yamamoto inoperable. Therefore, one of skill in the art would not have been motivated to combine Yamamoto with the filled groove of Fujihara, because doing so would render Yamamoto's device inoperable. Furthermore, nothing in Yamamoto or Fujihara suggests making such a combination, or even that such a combination is possible.

Furthermore, Yamamoto and Fujihara relate to different semiconductor devices. Fujihara is a semiconductor device having a built-in heat sink, whereas Yamamoto requires an externally mounted heat sink in order to minimize the area on the light-output face taken by the electrodes (Yamamoto, column 1, lines 43-48). Therefore, combining the references would require a significant redesign of Yamamoto to compensate for the loss of the external heat sink and to accommodate the built-in heat sink of Fujihara. It is not obvious how this combination would be made. At least for this reason, claim 2 should be allowable, and claims 5-7 are allowable at least by virtue of their dependence on claim 2.

The Examiner rejects claims 18-19 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 6,239,033 to Kawai. The Examiner acknowledges that Kawai does not disclose that the substrate is made of GaN as claim 18 requires. However, the Examiner alleges that it would have been obvious to one having ordinary skill in the art at the time of the invention to make the substrate of GaN and the semiconductor layer with a GaN base, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. Applicants respectfully disagree.

The use of GaN or sapphire as a substrate is not merely a matter of design choice. In particular, sapphire is harder, more chemically stable, and provides better heat dissipation than

GaN, making the manufacture of semiconductors on sapphire substrates easier than on GaN substrate. In fact, the invention of Kawai is directed to overcoming problems such as reduced high frequency operation and high-power output that plagued semiconductors formed on sapphire substrates (Kawai, column 3, lines 26-43), and thus the arrangement would not necessarily be suitable with a different substrate such as GaN. The mere fact that a material may be known is insufficient for its inclusion in the cited art in view of the Kawai disclosure.

However, using a sapphire substrate in conjuction with GaN semiconductor layers (such as what the Kawai discloses) inherently has other problems, as the difference in lattice constant that occurs between the sapphire substrate and the GaN layer results in a substantial number of surface dislocations in the GaN layer. In spite of this, and because of sapphire's strength and heat characteristics, conventional semiconductors such as those of Kawai continue to use sapphire substrates.

Applicant's invention using a GaN substrate avoids the lattice constant difference present with sapphire substrates, but is able to provide improved heat dissipation through the unique formation of the semiconductor layers and the formation of the groove therein. Therefore, the selection of the materials is not merely a matter of design choice, but provides an important structural and functional difference. Therefore, claim 18 is allowable over Kawai at least for these reasons, and claims 19-21 are allowable at least by virtue of their dependence on claim 18. While claims 20-21 are rejected over the combination of Kawai and Fujihara, Fujihara does not make up for the deficiencies in Kawai.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the

Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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